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Title:	FLIR Infrared Camera Effective Use, Data Collection, and Tips
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FLIR Infrared Camera

Effective Use, Data Collection, and Tips

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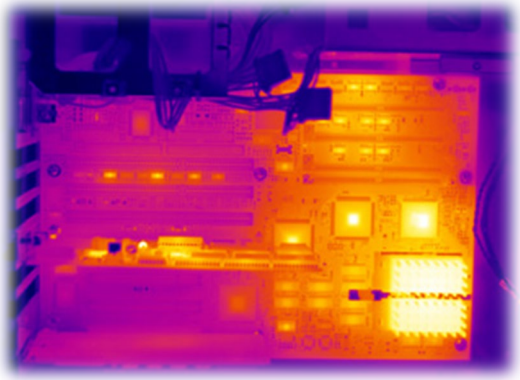
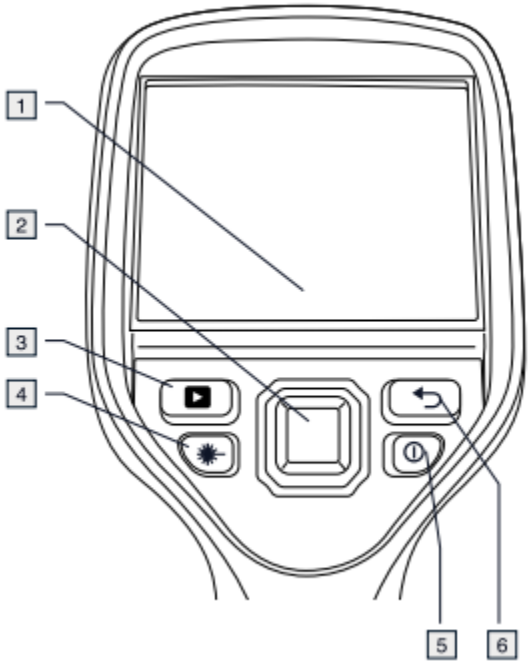
Introduction to FLIR Imaging

- FLIR Infrared Camera Features
  - Can capture infrared and visible images
  - Passive measurement
  - E Series cameras can measure temperature differences between multiple user-specified locations
  - E Series
    - Max Min and Auto Range Function
  - Laser pointer for reference
  - Picture in Picture and MSX infrared/digital camera capability
  - E Series uses touch-screen and button interface
  - Two temp ranges available
    - 0-650 C (32-1202F)
    - -20-120C (-4-248F)



Controls and Button Layout

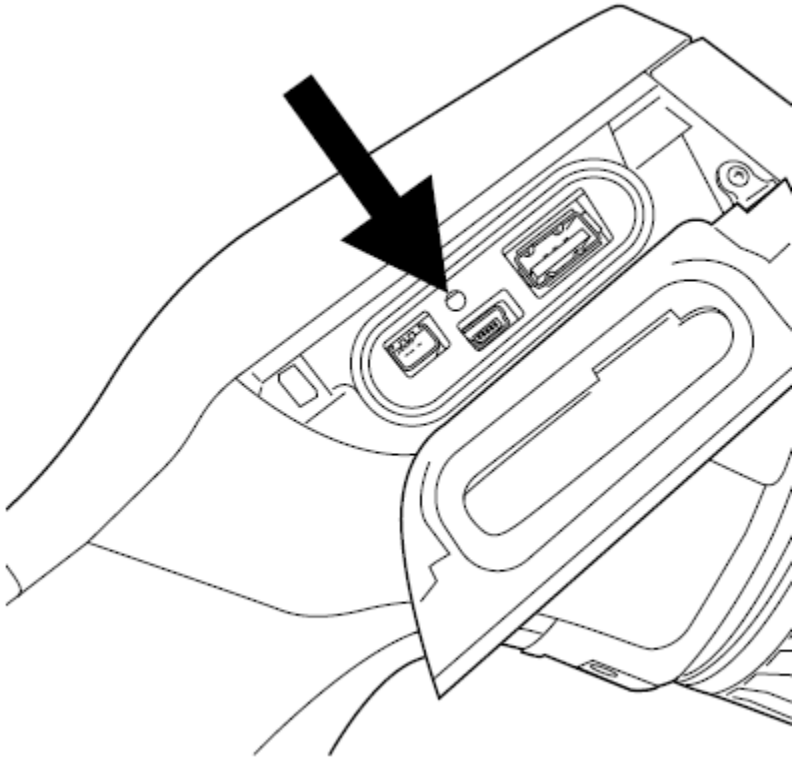


1. Touchscreen
2. Navigation Pad
3. Image Archive
4. Laser Pointer
5. On/Off
6. Back/Return

Tripod Mount

- FLIR cameras have specific mounts that can be used to set them up on tripods
- NOT common tripod thread

Battery Indicator

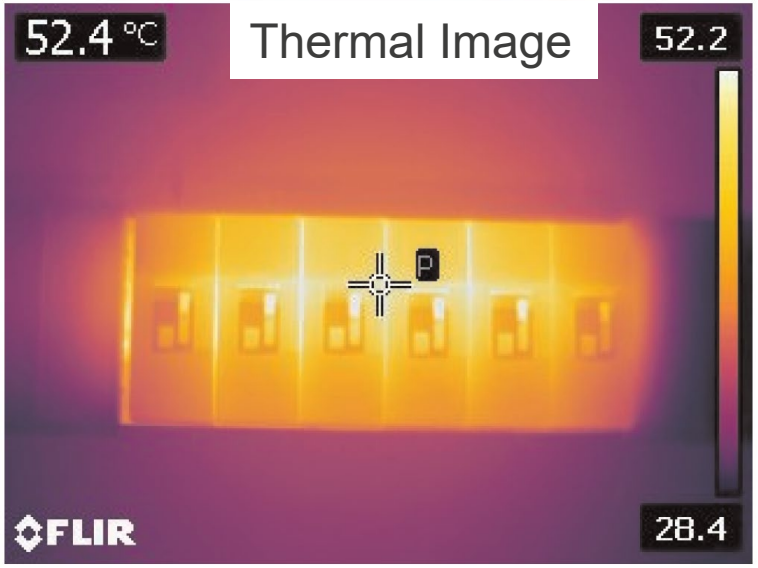


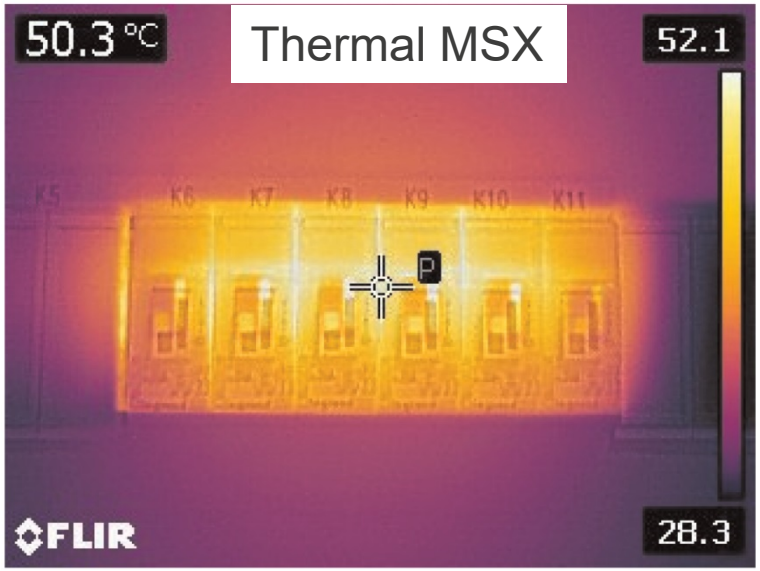
- LED shows battery status
- Will drain battery
- Hold power button down until LED turns off

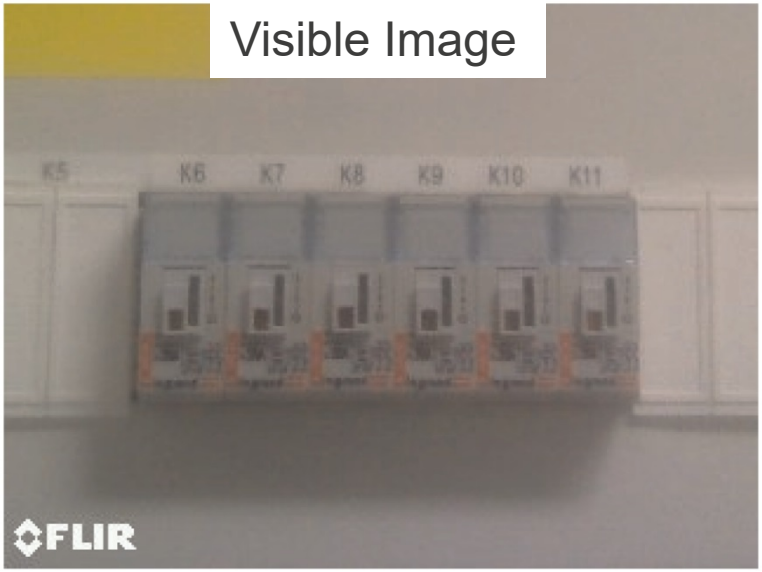
Typical Screen Display

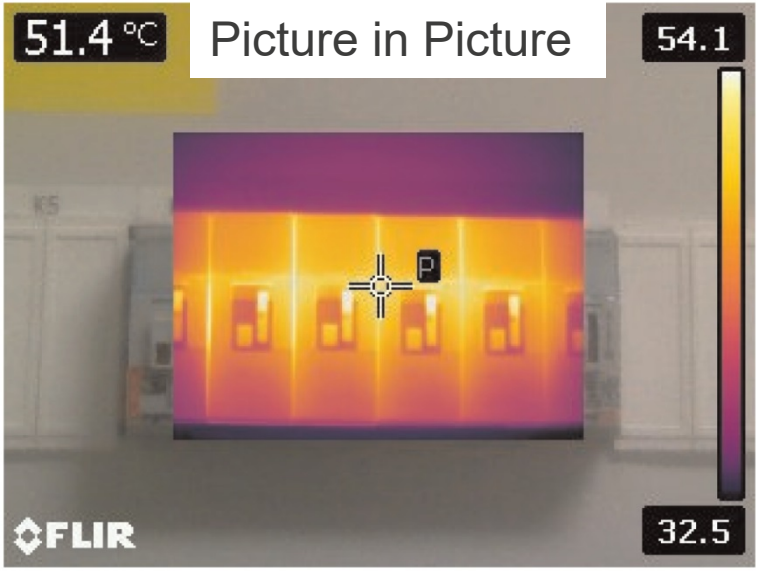
To access the menu screen, tap the touchscreen or touch menu button.

Image Modes

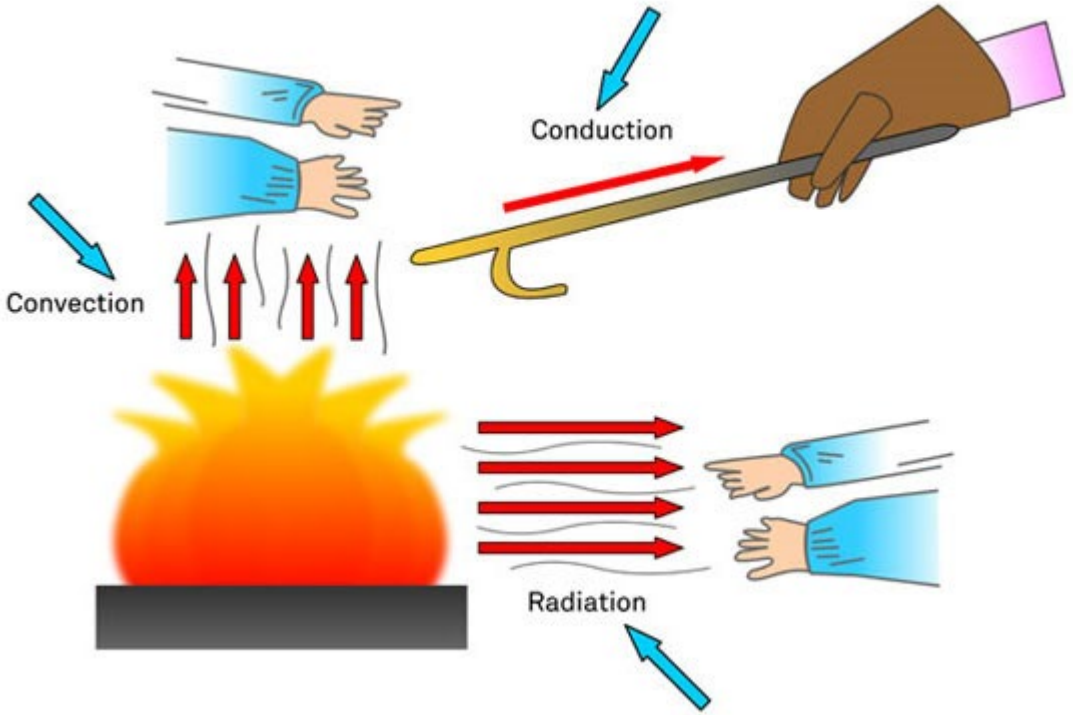

52.4 °C
Thermal Image
52.2
28.4
FLIR


50.3 °C
Thermal MSX
52.1
28.3
FLIR


Visible Image
FLIR

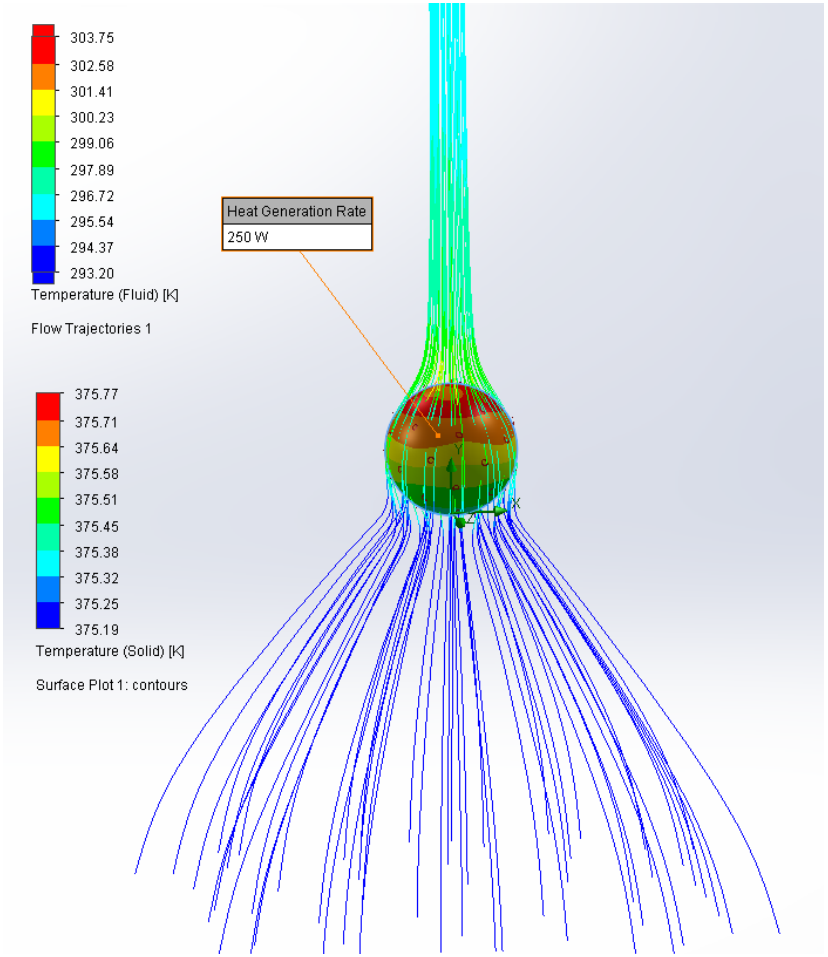

51.4 °C
Picture in Picture
54.1
32.5
FLIR

Conduction, Convection, and Radiation



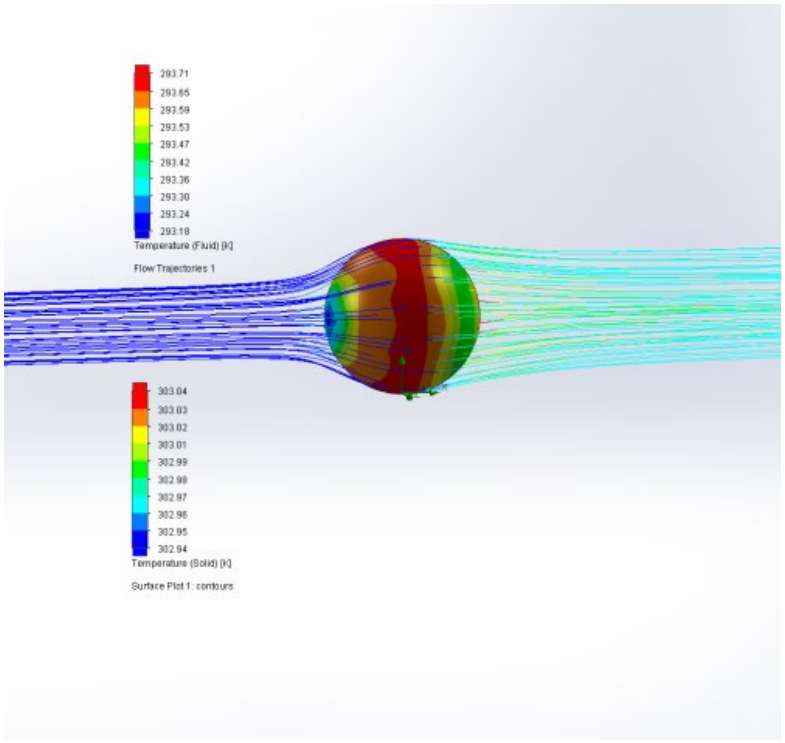
Natural Convection, Al sphere 250W

- Natural convection cooling the sphere due to buoyancy of warm air

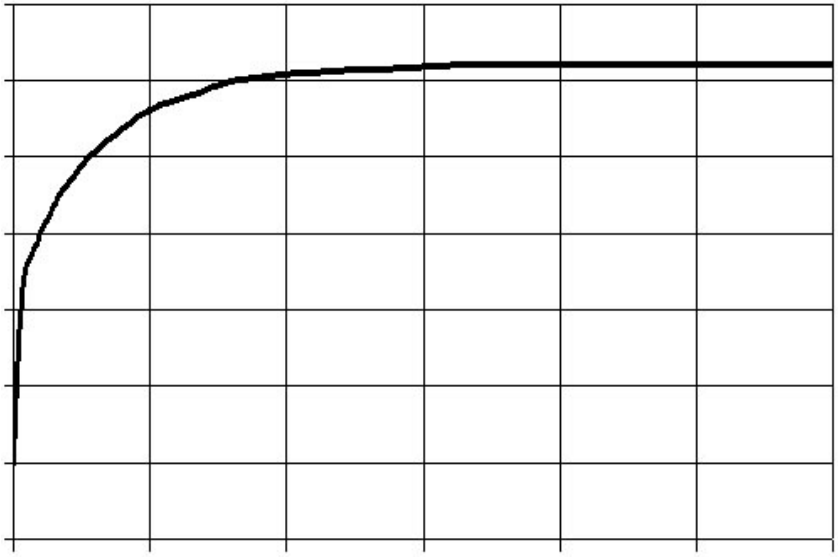


Forced Convection, Al sphere, 250W

- Much lower temperature than natural convection example
- This is due to the effect of forced convection
- Convection can cause unusual temperature profiles.
- Pay attention to atmospheric conditions.

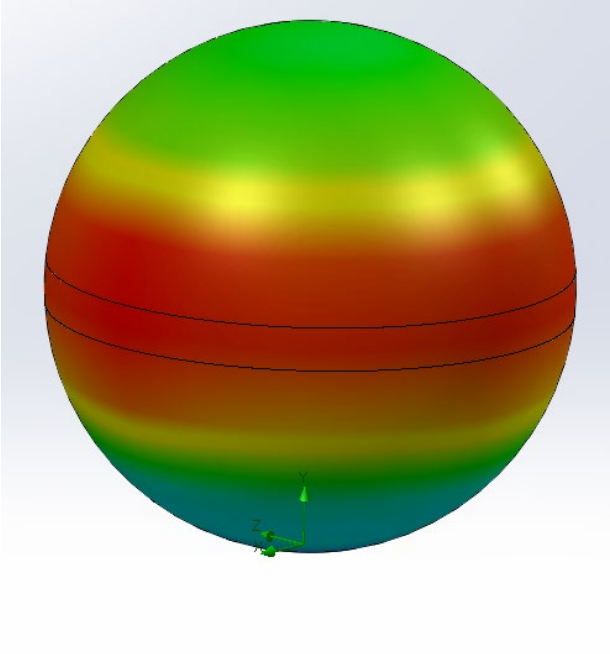


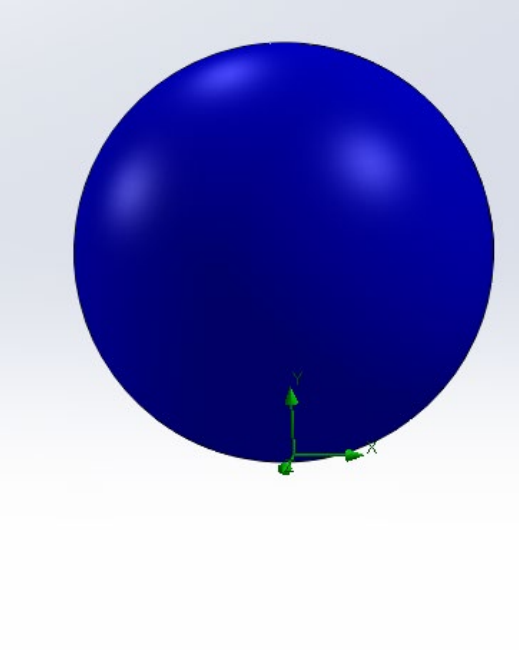
Steady State Behavior



- Temperatures will stabilize to a constant value when heat loss equals the heat generation
- Look out for deviations from this behavior

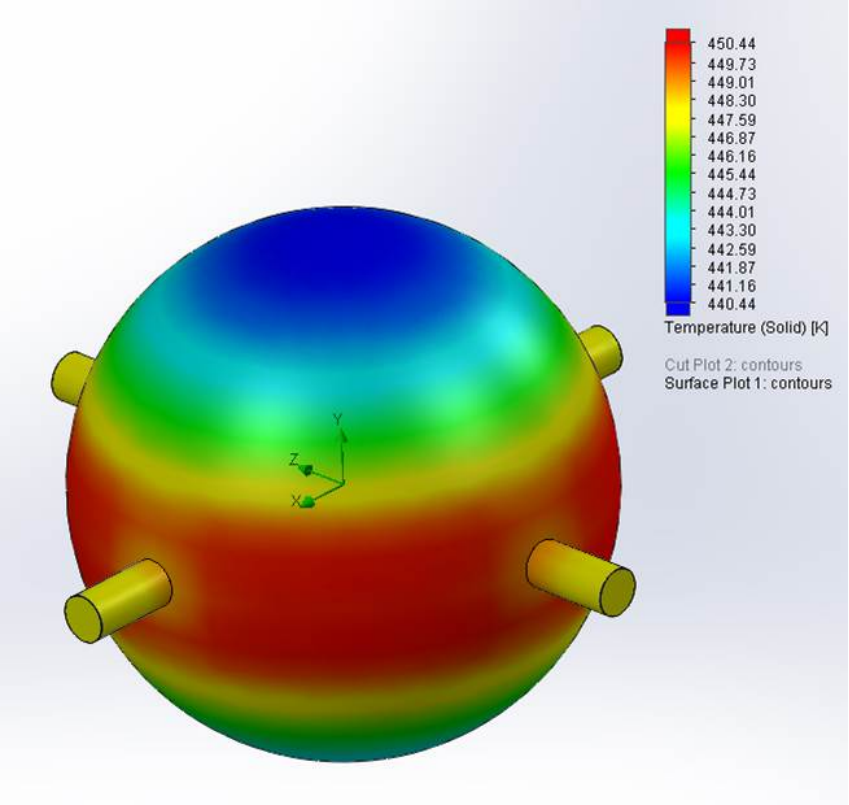
Heat Transfer in Objects

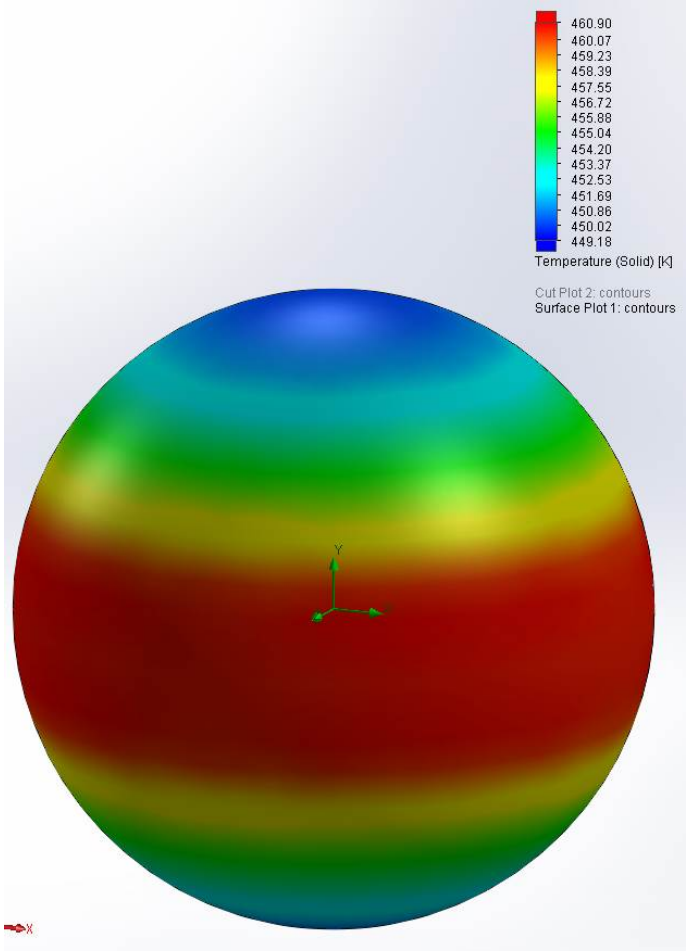




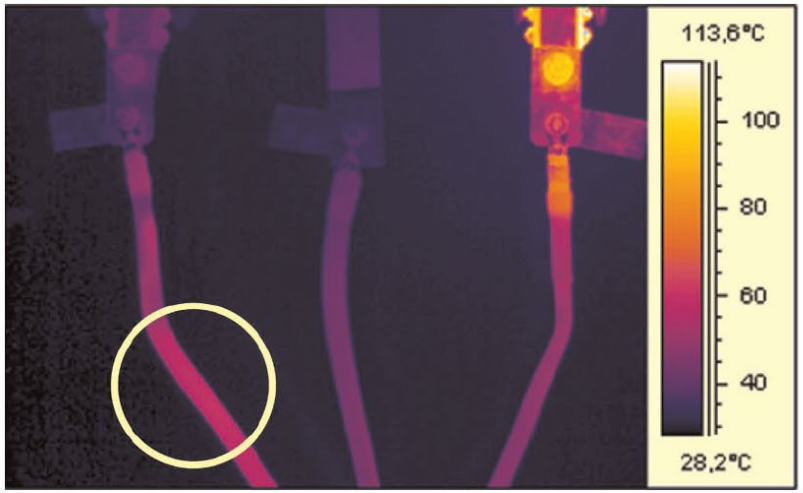
Thermal signatures of the two items above could have significant impact on render safe action plan.
If object on left starts to look like the object on the right or vice versa, Home Team personnel would need to know

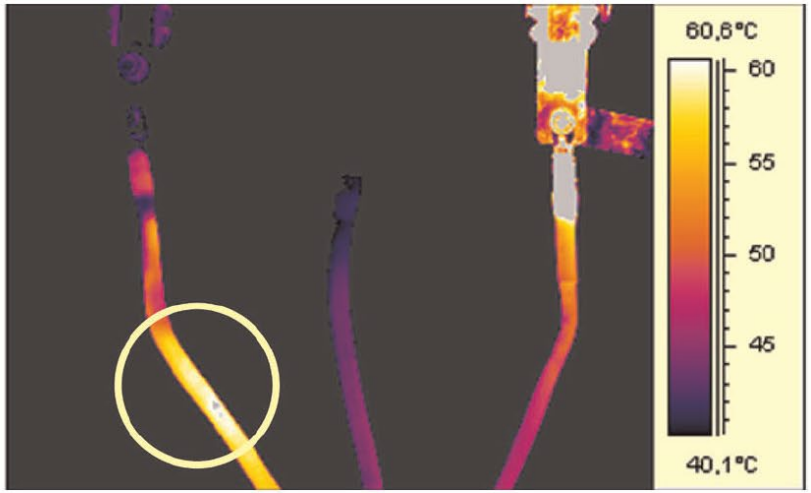
Sample Object



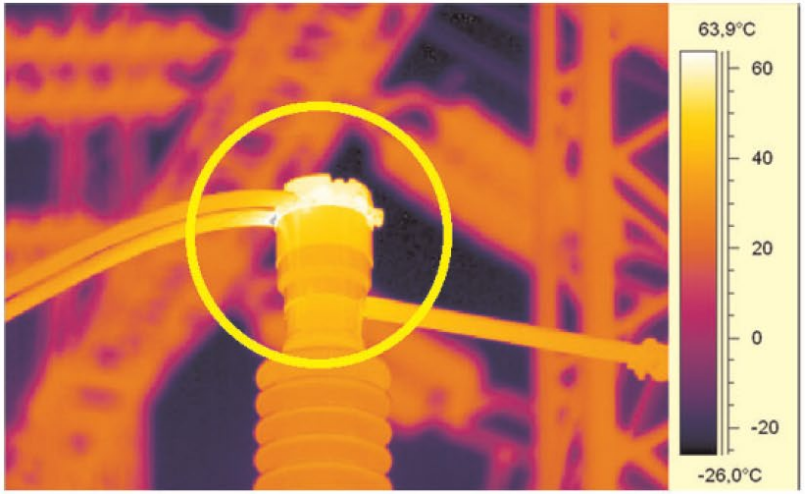


Automatic vs. Manual Scale

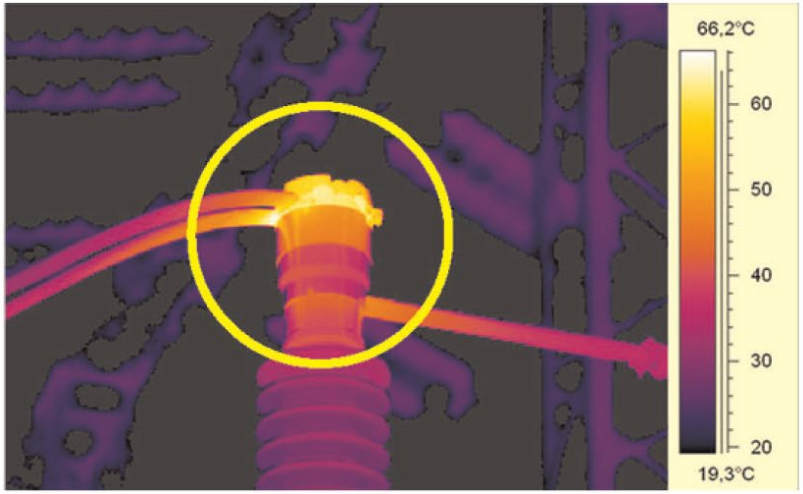




A (automatic)

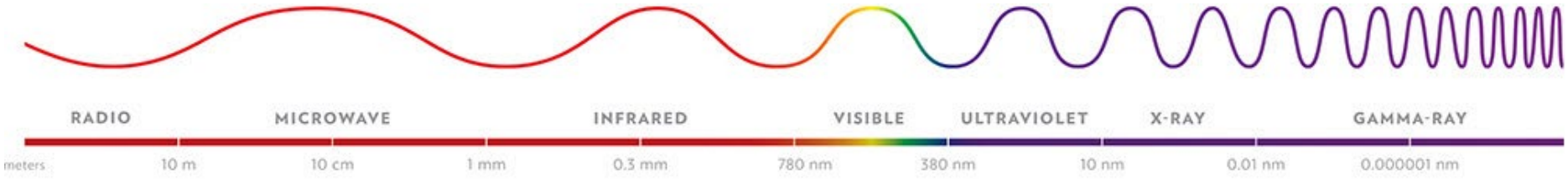


M (manual)



Infrared… What is it?

- Infrared (IR) is invisible radiant energy
- Longer wavelength than visible light
- Emitted or absorbed by molecules when they change in rotational and vibrational movements (Any heating)
- Light and electromagnetic waves will also cause a surface to heat the molecules and emit IR energy (How the sun heats the earth)



Factors Affecting FLIR readings

- Emissivity
- The **emissivity** of a material (usually written *ε* or *e*) is the relative ability of its surface to emit energy by radiation. It is the ratio of energy radiated by a particular material to energy radiated by a black body at the same temperature. A true black body would have an ε = 1 while any real object would have ε < 1.
- In general, the duller and blacker a material is, the closer its emissivity is to 1. The more reflective a material is, the lower its emissivity. Highly polished silver has an emissivity of about 0.02.

List of Common Emissivities

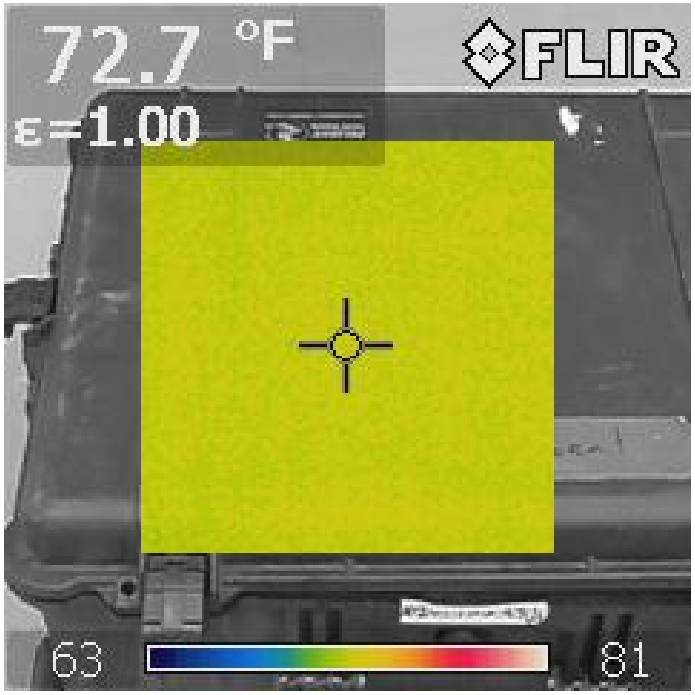
Metal	Emissivity	Non-metal	Emissivity
Bare aluminum	0.02–0.4	Concrete (rough)	0.93–0.96
Gold	0.02–0.37	Glass	0.76–0.94
Copper	0.02–0.74	Wood	0.8–0.95
Lead	0.06–0.63	Carbon	0.96
Brass	0.03–0.61	Human skin	0.98
Nickel	0.05–0.46	Paper	0.7–0.95
Steel	0.07–0.85	Plastic	0.8–0.95
Tin	0.04–0.08	Rubber	0.86–0.94
Silver	0.01–0.07	Water	0.67–0.96
Zinc	0.02–0.28	Sand	0.76–0.9

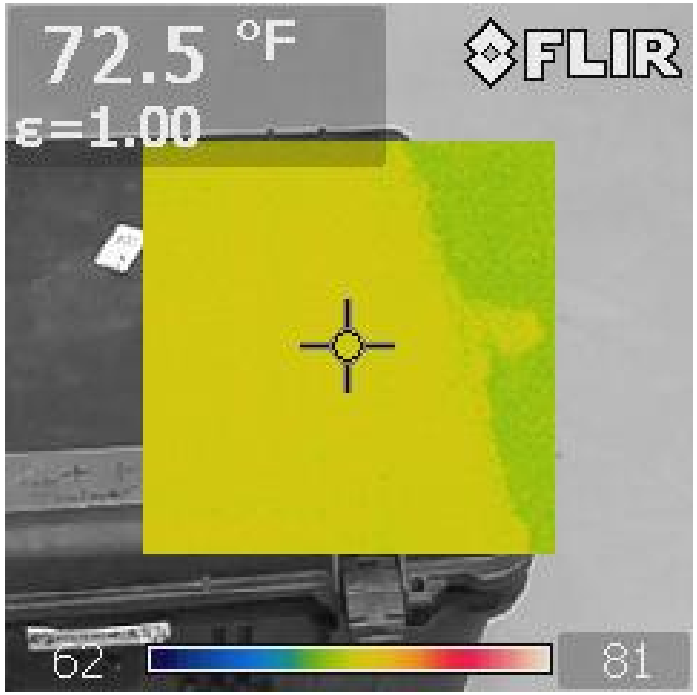
- **FLIR built-in library**
- **Uncertainty**
  - –Color?
  - –Surface Finish?
  - –Reflections?
- **Why chance a bad measurement?**
- **There is an easy solution…**

Tape

- Hockey Tape
- Electrical Tape
- Gorilla Tape

Thermal Imaging Example



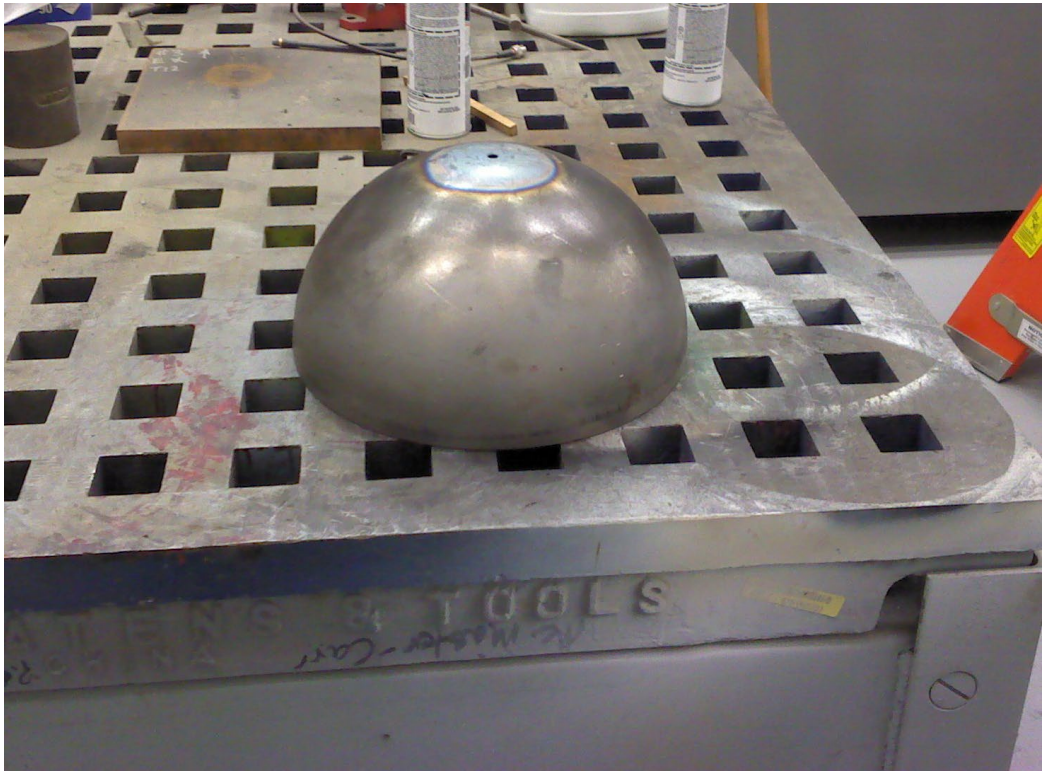


Black Pelican Case: Indoors (Ambient Temp ~72 F)

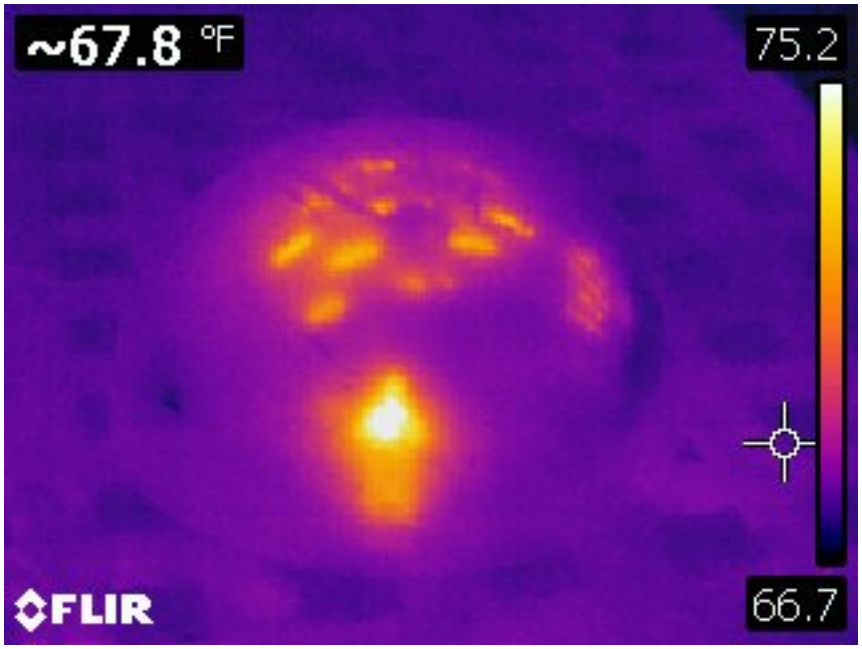
Note floor showing at lower temp gradient

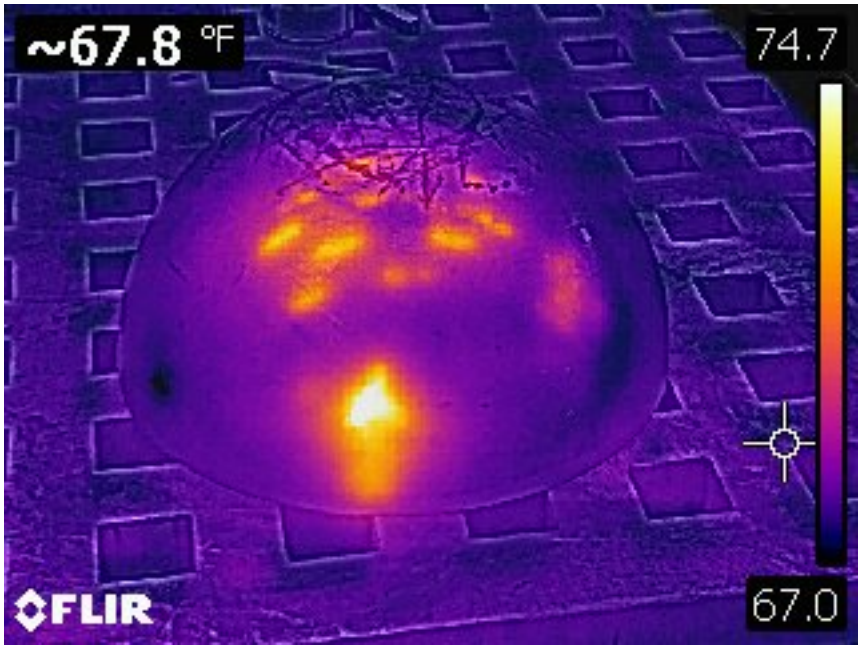
Thermal Imaging

- Item at room temperature (~70F)



Thermal Imaging

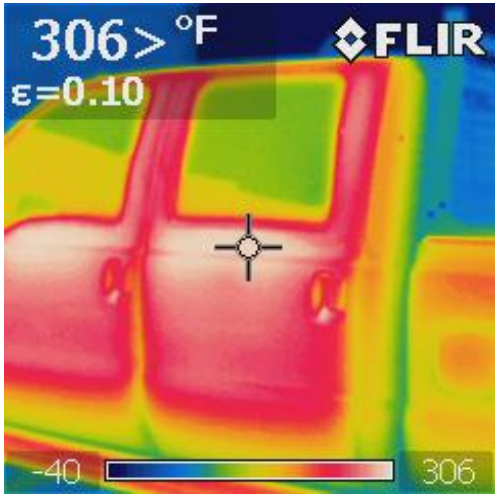


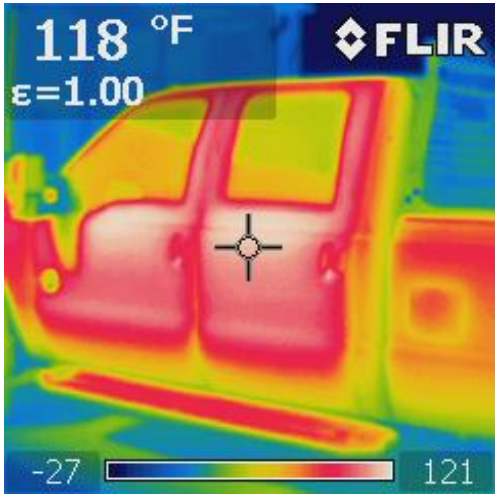


Thermal Imaging Example

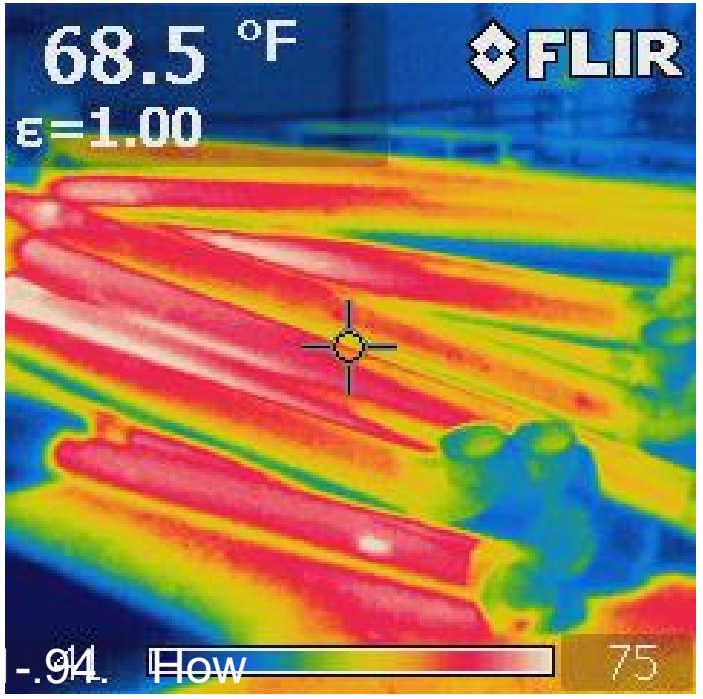
Warm day, Sun shining….No wind

What temperature reading do you trust?



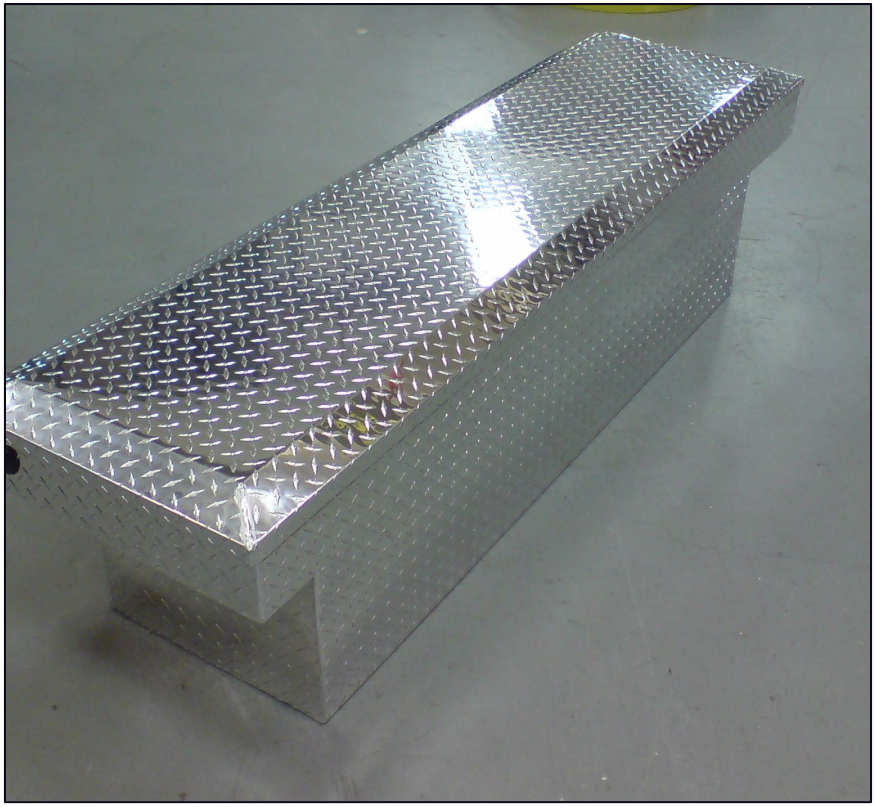


Thermal Imaging Example



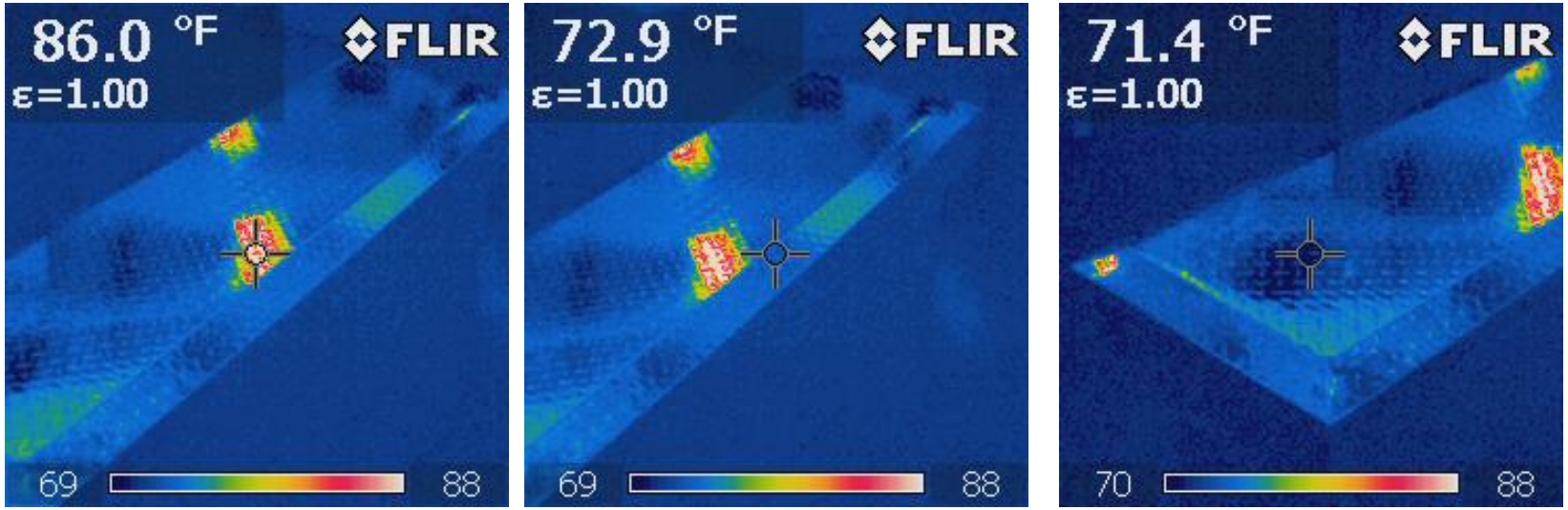
Thermal Imaging Example

- **What could go wrong while measuring thermal signature of the item below?**



Indoors
Air Temperature ~72°

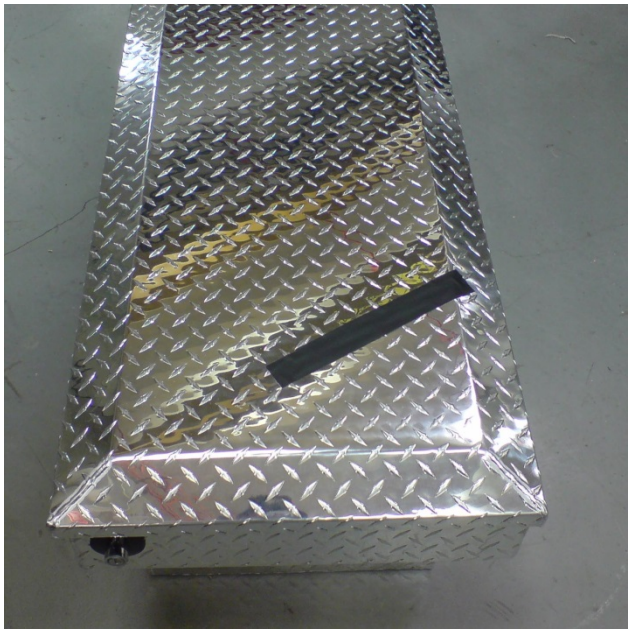
Thermal Imaging Example



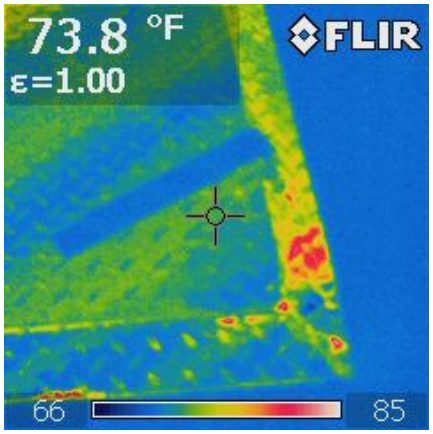
What is being measured?
Which measurement can you believe?
What could be wrong?

- Reflectivity, Emissivity or Both?

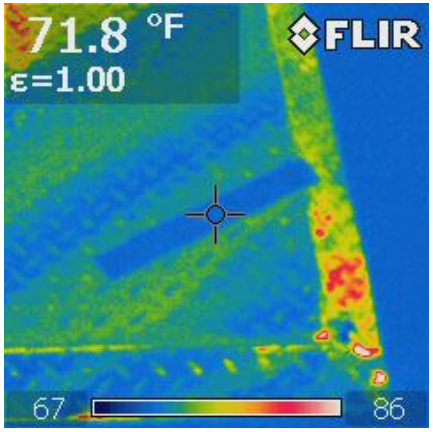
Thermal Imaging



Black Tape on Shiny Box

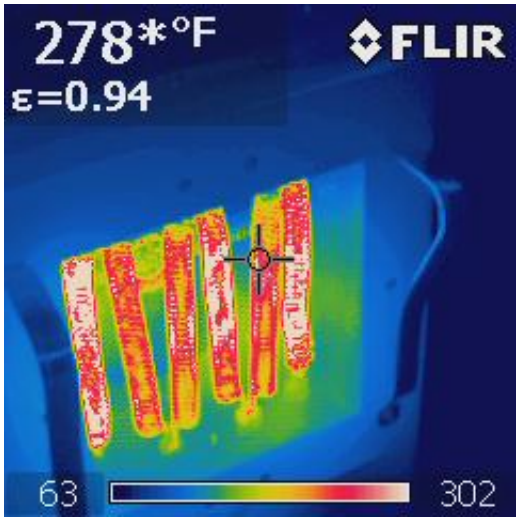


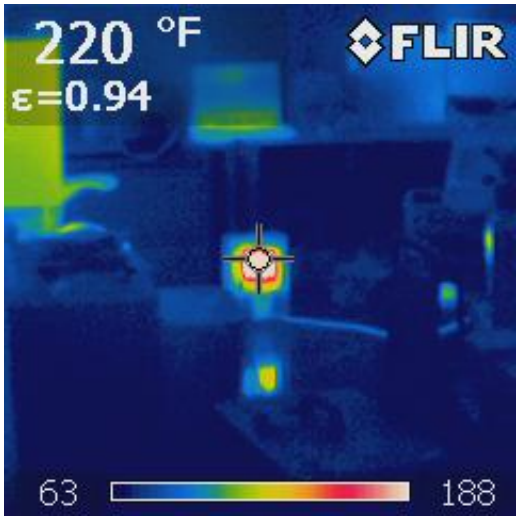
Surface

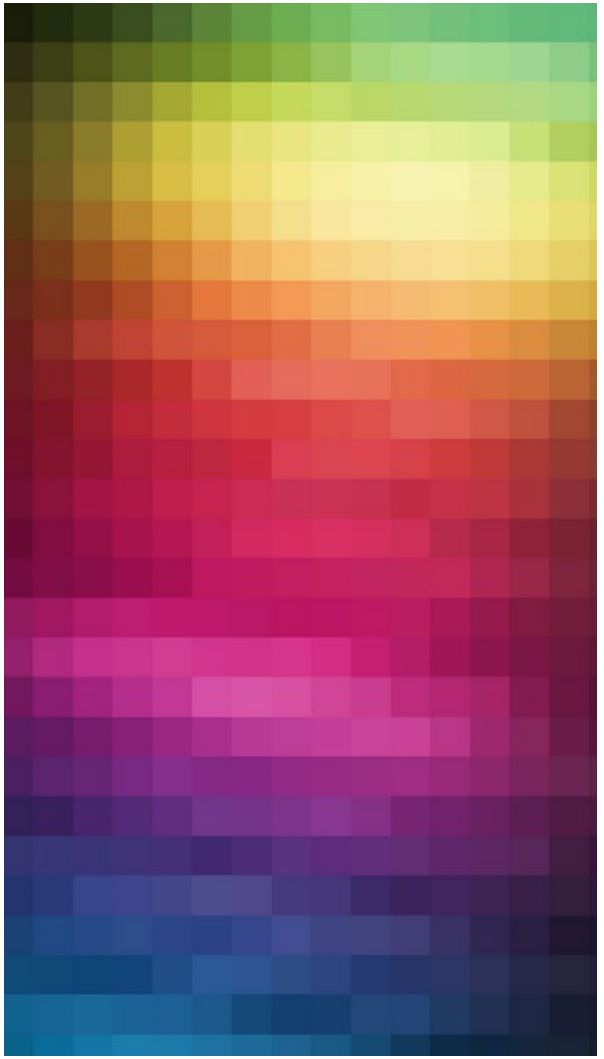


Pointer on Black Tape

Thermal Imaging Resolution







The FLIR Infrared Camera

- **The utility of the FLIR is for determining if the temperature of a system is changing.**
- ***In general, the duller and blacker a material is, the closer its emissivity is to 1. The more reflective a material is, the lower its emissivity. Highly polished silver has an emissivity of about 0.02.***
- **Two objects at the same physical temperature will not show the same infrared image (temperature) if they have differing emissivity.**
- **Use dull tape to make a more accurate measurement on objects with unknown emissivity**
- **Leave camera set for emissivity e=1.0**
- **Only useful for determining surface temperature of object.**
- **Send information back in 30 minute intervals**

FLIR Image Reporting

Tips:

- Send IR images with AS MUCH information as possible.
- Rename images to something useful (Emissivity, Ambient Temperature, Description, etc.)
- Example: Object1_Left_e1_75F.jpg
- This practice improves communication to anyone viewing the file
- Send FLIR information back in 30 minute intervals
- Immediately report non-steady state behavior